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RELEASE OF NEW LOCALLY-ADAPTED LINES OF
CORIANDER, CARAWAY AND DILL FINAL REPORT

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Final Report

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TAD Project 20010360

Release of New Locally Adapted Lines of
Coriander, Caraway and Dill.

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Abstract - this project supported advanced screening and final selection trials for new coriander, caraway and dill lines developed by the Crop Development Centre. Severe drought conditions at planting impaired emergence of most of the screening and selection trials - this limited the validity of yield and quality of the resulting data. **Due to this crop failure, the screening and selection trials will be repeated in 2003 as a no-cost extension of this project.** A disease nursery was established to allow for screening of new lines for disease resistance and to test fungicides against the key diseases attacking spice crops in Saskatchewan. Nurseries for blossom blight of dill, coriander, caraway and cumin were established. Several fungicides were tested against the organism that causes blossom blight of caraway - however, limited control was achieved. Multiple introductions of the *Aureobasidium* sp fungus thought to cause blossom blight in coriander failed to produce any disease. A number of seed treatments were evaluated for their potential to enhance germination and seedling performance of a range of small-seeded spice crops. However, none of the treatments represented any significant improvement over standard practices.

Project Background

Production and processing of spice crops represents a bright spot in the future of Saskatchewan's agricultural sector. Saskatchewan growers have established a worldwide reputation as low-cost suppliers of superior quality spices. Local opportunities are available to add value to these crops through preservation, extraction and blending. The marketplace for spices is demanding, rapidly changing and highly competitive. To stay viable, Saskatchewan's spice sector must have access to locally adapted, disease resistant varieties with the quality characteristics required in the marketplace. Dr. A. Slinkard has been working on spice breeding since 1994. Dr. Slinkard's program has produced superior lines (yield and quality) of coriander, caraway, dill and fenugreek. This program will conduct the final selections of these lines and will confirm their suitability for production under the disease pressure encountered in Saskatchewan. Leaf and blossom blight has the potential to devastate coriander, caraway and dill fields. This disease complex is well established in Saskatchewan and has been identified by the industry as a key factor restricting expansion of production.

Objectives of the Project :

- 1) to conduct final selection trials required prior to release of the new lines of coriander, caraway and dill developed by Dr. A. Slinkard
- 2) to evaluate the disease tolerance of the new lines relative to the existing standard lines.
- 3) to identify other opportunities to improve production of spice crops in Saskatchewan.

PROGRESS TO PROJECT COMPLETION - APRIL 1, 2003

Objective 1 : Selection Trials

The objective of this component of the program was to do final evaluation and selection from the breeding material of dill, coriander and caraway developed by Dr. Slinkard over the past 7 years. The material evaluated was :

Dill

- 25 lines derived from the standard cultivar "Mammoth". This parent was selected for its superior agronomic vigor and seed yields. "Mammoth's" oil content and quality are deemed acceptable. The objective is to produce a line with superior agronomic characteristics and seed yield potential.
- 25 lines derived from the parent "Bouquet". This line has unusually high limonene content, but relative poor seed yields. The objective is to isolate a line with equivalent or superior limonene content as well as superior yield potential.

Coriander

- CDC Major - a large seed coriander line with excellent vigor and yield potential and acceptable oil content and composition. Dr. Slinkard has developed 25 variants of CDC Major - the objective is to narrow this down, prior to its commercial release.
- CDC Minor - a small seed late maturing coriander type with superior oil content and quality. Dr. Slinkard has developed 25 variants of CDC Minor - the objective is to narrow this down, prior to its commercial release.
- high oil content types - Dr. Slinkard has selected a range of coriander types with exceptionally high oil content. The objective is to evaluate the yield potential of these lines to determine if they have any commercial potential.

Anise

- Dr. Slinkard has selected a number of lines from bulk material provided by local anise growers and commercial seed suppliers. Twenty lines of this material was observed in microplots. The best adapted lines from previous trials was observed in a replicated yield trial.

Ajowan, Niger, Cumin and Camelina

- Dr. Slinkard has obtained a limited number of lines of each of these crops. The lines were evaluated in microplots.

The 2002 field trials were established at the "Old Irrigation", Investigation and Preston sites of the Department of Plant Sciences, University of Saskatchewan in Saskatoon. The previous year, these plots were in fallow. Prior to planting the field plots were treated with the herbicide Treflan (trifluralin) at 1.0 l/ac. The Treflan was incorporated by light discing - this also represented the soil preparation step in 2002. Residual fertility levels in the field were determined to be adequate for the test crops.

The trials were seeded May 14th using a 4 row double disc cone seeder. The seed was planted relatively shallow (2 cm) in an effort to insure rapid germination. Each microplot was 3.5 m long with the rows were spaced 30 cm apart. in and between row). The microplots were not replicated. The yield trials for coriander and anise were replicated 5 or 6 times.

Conditions after planting in 2002 were not favorable for germination of shallow seeded crops. The soil was relatively dry at planting and post-planting rainfall was negligible. As no irrigation was available on these sites, emergence of many of the crops was staggered and incomplete. The slow and incomplete emergence also opened the crops to weed competition. Lorox (linuron) applied in mid-June (0.7 l a.i./a) helped check the weed problems but supplemental hand weeding was required through the season.

Problems with poor and uneven stand made the Coriander and Anise yield trials of limited validity - they were therefore ploughed under. Slow crop establishment, coupled with crop damage by an early August frost combined to delay maturity of the remaining 2002 spice trials. Many of the more marginal lines of the various test crops failed to mature in 2002 - the tests therefore served as a useful screening tool for maturity. Maturity was also very uneven, resulting in seed yield loss due to shattering and problems with quality due to varying levels of seed maturity.

The coriander plots were fully mature by October 8th. The plots were harvested with a Winterstieger small plot combine. Microplots of the other crops were hand harvested in late October. Standard methods were utilized for yield and quality analysis.

Results

CORIANDER

- a) Sub-lines of CDC Minor coriander - in a replicate trial no consistent differences were found among these sub-lines evaluated. Apparently, all of the lines that were bulked to produce Breeder seed of CDC Minor coriander were reasonably good.
- b) Sub-lines of CDC Major coriander - in a replicate trial no consistent differences were found among these sub-lines evaluated. Apparently, all of the lines that were bulked to produce Breeder seed of CDC Major coriander were reasonably good
- c) Micro plots - 18 microplots of coriander derived from individual plant selections from a line that was above average in percentage essential oil were grown in 2002. Four or five of these micro plots merit retesting to confirm that these differences are genetic. These will be grow in 2003. Many of these lines are small fruited - and small fruited lines tend to have a higher oil content. In some of the lines, the fruit size may be too small.

DILL

- a) A Breeder plot of a new, high yielding, high oil content line of dill was planted in 2002, but drought, hail and frost demolished it. Enough seed was saved to replant a Breeder seed plot in 2003.
- b) Microplots - nine 9 microplots of dill were grown in 2002 but due to poor stand and early frost none produce enough seed to test for percentage essential oil.

Objective 2. Disease Screening Program

Background - blights attacking the foliage and flowering structures represent an ongoing, widespread and economically serious problem in production of spice crops including coriander, caraway, anise and dill. These diseases occur sporadically (time and space) but are usually associated with wet weather. Incidences increase in crops with restricted rotations (ie; biennial caraway).

Duczek (2002) found that symptoms characteristic of blight could be caused by a range of organisms ... but that in coriander, caraway and dill there appeared to be a dominant causal organism ...

Coriander - *Aureobasidium* sp

Caraway - *Ascochyta* sp

Dill - *Fusarium culmorum* and *F. sporotrichioides*

In preliminary studies with cumin, blight symptoms arose following inoculation with various *Fusarium* species (*Fusarium culmorum* and *F. sporotrichioides*), but not with *Aureobasidium* sp, or *Ascochyta* sp. This diversity of organisms with the potential to cause blight might explain why problems with blight are more serious in cumin than in the other crops.

The potential to control these problems with fungicides is complicated by ; a) their sporadic nature, and b) the indeterminant flowering of the crop necessitates repeated applications of non-systemic protective products

Growers are interested in; a) development of resistant germplasm and b) potential for chemical control.

Disease nurseries represent the standard approach for screening germplasm for disease resistance and to test crop protection products. A well managed nursery provides consistent, predictable and controlled infection - these factors are critical when assessing a cultivar's reactions to disease and when evaluating the utility of any disease control product. The first task of this project was therefore to create a disease nursery for the blight diseases affecting the key spice crops grown in Saskatchewan.

Site background - the site selected for establishment of the disease nursery is part of the Department of Plant Sciences Horticulture field plots in Saskatoon Saskatchewan. The site features a Sutherland series heavy clay loam soil (pH 7.8, EC 0.9) and is well protected with caragana shelter belts. The test plot was in a longterm apple orchard until 2000 and therefore had no recent history of cropping to spices. In 2001, the area was heavily manured and then kept in fallow.

The strengths of this site as a disease nursery area are;

a) the site is ideally suited to development of disease. The fertile heavy clay soil produces extremely vigorous crop growth. The resulting lush canopy is prone to the development of foliar diseases.

B) the site is surrounded by shelter belts. The resulting reduction in air flow through the canopy

creates conditions suitable to humidity-dependant canopy diseases.

C) the site has access to irrigation. This allows manipulation of both the soil and canopy moisture status in a manner conducive to generation and study of disease.

D) the site is close by the Department of Plant Sciences - this facilitates management and monitoring of the plots.

Soil tests (0-12") conducted in the spring of 2002 indicated the nutrient levels in the test plot area were : N - 120 #/a, P2O5 - 100 #/a and K2O - 1000 #/a. These levels are well above the minimum requirement for the proposed test crops. The excess fertility will likely promote lush growth which is desirable from the perspective of blight induction.

The disease nursery was equipped with a wheel-move based irrigation system which could be used to both promote crop growth and to create environmental conditions conducive to disease. The total plot area was 1.1 ha = 2.8 acre, with 0.2 ha set aside for coriander and caraway and 0.1 ha for dill and anise.

Prior to planting, the plot area was double disced to break up clods and expose the last roots from the previous apple orchard. The herbicide Edge (ethafluralin) was applied at 7 kg/a, after which the plots were lightly harrowed to incorporate the herbicide and provide a smooth seedbed.

Low snow pack coupled with minimal spring rains resulted in exceptionally poor soil moisture conditions in the spring on 2002. This situation was exacerbated by the multiple cultivation steps required to get the field plots ready for seeding. **Although one of the original objectives of this program was to screen the disease resistance of the new releases from Dr. Slinkard's breeding program, it was felt that the risk of crop failure due to drought stress in the spring of 2002 was too high to merit wasting the limited amount of seed of the new lines that was available.** Instead, the plots were established using commercially available seed of the lines commonly employed by Saskatchewan growers.

Dill - cv. Mammoth - a vigorous high yielding cultivar, well adapted to Prairie growing conditions.

Coriander - CDC Major. A recent release from the CDC program, this early maturing line produces good yields of medium-sized seed pods. The oil content and quality is rated as acceptable.

Caraway - mixture of annual and biennial type. The annual serves as a nurse crop for the biennial while also acting as a starting point for disease.

Cumin - a land race obtained from Dr. Slinkard.

The coriander, caraway and dill seed was supplied by Gary Sweitzer of Eston SK. There was no evidence of significant disease problems in Mr Sweitzer's 2001 crop. However, he has had blight problems in other years. Fresh cumin seed could not be obtained in time for the 2002 cropping season. Limited amounts of relatively old cumin seed was obtained from Dr. Slinkard's collection.

The plots were seeded on May 20th utilizing a 4 row double disc small plot press drill type seeder. This unit plants at 30 cm between row spacings with 2 cm between seeds within a row.

As the drought continued, and it became apparent that the crop was not going to emerge without supplemental moisture, we began to irrigate the seeded areas. Irrigating-up small seeded, shallow planted crops on clay soils is difficult as the soils tend to crust. To avoid crusting and problems with excessive cooling of the seed bed, we kept the total amount of precipitation applied at a setting to less

than 0.5 cm, but irrigated frequently (every 3 days). The resulting stand of coriander and dill was > 80%, while caraway ranged from 30-50%. The cumin stand was extremely poor (<5%). Cumin is renowned for its slow emergence and sensitivity to both temperature and moisture stress. Stress sensitivity of the cumin crop would have been exacerbated by the advanced age of the seed used.

Once the crop was established, irrigation was used to adjust the total amount of moisture received by the crop to 2 cm weekly. This regime minimized moisture stress on the crop and produced a lush canopy which would be prone to blight-type disease.

The Edge treatments provided reasonable complete weed control through the first 4 weeks of the cropping period. However, by late June, problems with red-rot pigweed, mallow and common groundsel were apparent throughout the plot area. The plots were therefore treated with linuron (Afolan F) at 0.7 l/a. All crops showed excellent tolerance of this relatively high rate of linuron. The stands of dill and coriander crops were likely complete and vigorous enough to have out-competed these weeds without the aid of this additional application of herbicide. However, survival of the cumin and caraway plots was uncertain without this supplemental weed control measure. Some additional hand control of weeds was required in both the cumin and caraway plots throughout the season - reflecting the non-competitive nature of these crops.

Caraway

On August 1, half of the caraway plot was inoculated with dried leaf and stem material obtained by Dr. Duczek from a biennial caraway field that had severe problems with blight in 2001. This material was spread by hand and the plots were then lightly irrigated to promote establishment and spread of the disease.

By mid-August the first symptoms of blossom blight were apparent in the caraway crop. The initial outbreaks were localized near the center of the plots in an area which had received the crop residues from the growers field. The infection showed up the classic discoloration of the blossoms, with no seed set occurring in the affected flower. However, not all flowers on an infected plant were damaged, suggesting very specific conditions required for infection, development and spread of this disease. There was some apparent lateral spread from the initial infection loci, by the end of the growing season at least 10% of the flowers on every plant were affected. In the worst hit areas, the plants were essentially killed by the disease. Following arrival of the blight the irrigation management practices were altered to maximize spread of the disease. The crop was lightly watered every 1-2 days with the objective of maximizing canopy wettness.

With the arrival of the blossom blight in the caraway we instituted our fungicide screening program. On August 18, one week after the initial infection was observed, 2 meter wide spray strips were established across the caraway plot. This delay in implementing the spray program was designed to allow the infection to spread beyond its point of origin. It was recognized that "after the fact" sprays would not protect blooms already infected by the *Ascochyta* blossom blight. Since caraway has an indeterminate flowering habit, many new blooms were established after the onset of the spray program. Our objective was to evaluate the products' potential to protect these new blooms. The crop was at about 10% bloom at the time of the first fungicide treatment. Each spray strip was surrounded by a 3 m wide unsprayed "spreader strip". This management approach insures very high disease pressure in the sprayed areas.

The following potential control products were tested :

Quadris (azoxystrobin) - a newly registered product with translaminar systemic activity. Quadris is known to have good activity against the ascochyta that attacks pulses. Preliminary field screening trials by Ducek in 2001 and 2002 also indicated some degree of blight control could be achieved using Quadris.

Bravo (chlorothalonil) - standard protectant. Known to be effective against ascochyta in pulses

Rovral - (iprodione) - a combination of protectant and eradicant activity.

Benlate (benomyl) - a systemic product with a wide spectrum of control but has been deregistered

Tilt (propiconazole) - a broad spectrum systemic product

Ronilan (vinclozolin) - contact product effective against a wide spectrum of foliar diseases.

The products were applied with a CO₂ driven backpack sprayer with 8002 nozzles. Ground speed was regulated to deliver the recommended volume of spray/unit area. This is critical, as the efficacy of protectant-type products hinges on uniform thorough coverage. The treatments were repeated one week later to insure thorough coverage. The crop had progressed to 20% of full bloom at that time.

The incidence and severity of disease in both the spray strips and adjacent check areas was evaluated weekly for the remainder of the cropping season. Each plot was sampled at 10 randomly selected points at the severity of disease was rated based on a 0-5 scale (0=no infection, 5=plants dead).

On Aug 29, (8 days after the second fungicide treatment) half of each spray track received a third application of fungicide. This final treatment was implemented in recognition of the fact that any blooms established since the previous application would be un-protected, unless the control products exhibited acropetal systemic activity. The crop was at 90% bloom at this stage. The weekly survey of disease severity continued through until harvest.

Results

The disease was non-uniformly distributed throughout the plot area, with severely damaged focal points grading into relatively healthy areas. This variability in initial infestation, resulted in corresponding non-uniformity in disease pressure across the spray tracks. The resulting variability tended to obscure some of the treatment effects. The data for September 8th illustrates some of the key treatment trends (Table 1). Due to variability in disease levels across the field, treatments are best compared to the adjacent untreated control areas, not to each other.

Table 1. Effect of fungicidal sprays on disease severity ratings (0-5) for caraway infested with *Ascochyta* blossom blight - September 8th 2002.

	Sprayed Once			Sprayed Twice		
	Sprayed	Control	Difference	Sprayed	Control	Difference
Rovral	0.8 ^z	1.4	-0.4	2.0	1.4	+0.6
Quadris	0.6	1.8	-1.2	1.0	1.8	-0.8
Bravo	0	1.7	-1.7	0.8	1.7	-0.9
Ronilan	1.2	1.5	-0.3	2.2	1.5	+0.7
Tilt	2.6	2.4	+0.2	2.4	2.4	0
Benlate	2.6	1.8	+0.8	3.2	1.8	+1.4

^z Severity ratings from 0 = no disease through to 5 = crop killed by disease.

It appears that **Quadris** and **Bravo** both provide some degree of control of blossom blight in caraway. The other products were either ineffective or in some cases actually appeared to exacerbate disease problems. The second application did not appear to produce any significant benefits and in some cases actually produced poorer results than the single application. It is possible that passing the sprayer through the plots have been spreading the disease.

The results suggests the need for further research. Positive responses to application of Quadris were noted in field scale trials conducted by Duczek in 2001 and 2002 although the control appeared to breakdown relatively rapidly. Some areas for consideration may be;

- a) the need for preventative rather than curative spraying
- b) the need for multiple applications
- c) the need for complete coverage of the field in order to reduce inoculum potential
- d) the need to examine alternate control products
- e) the need to develop disease-resistant locally adapted lines.
- f) the need to use integrated pest management practices rather than relying on a single approach to disease control. Irrigating the crop once the disease was apparent is clearly not a practice to be recommended.

The annual caraway crop was harvested at full maturity. The crop residues were spread over the plot area to serve as inoculum in the 2003 crop.

Coriander

When the coriander began to bloom in mid-July, the plots were inoculated with *Aureobasidium* which is the putative causal organism of blight in coriander. The inoculum was a spore suspension collected from 2 week old PDA plates of *Aureobasidium* generated from stock cultures provided by Dr. Duczek. The *Aureobasidium* was applied @ 1×10^6 spores/ml using a CO₂ powered backpack sprayer to create a 2 m wide sprayed strip running both the length and the width of the coriander plot. The total number of spores applied in the plot area was 4×10^8 . Inoculation occurred in the late afternoon and the plots were given a light watering immediately afterwards to produce conditions conducive to establishment of the spores. From that point forward, the standard irrigation regime was altered to promote disease development. The plots were lightly watered at least twice weekly. Twice weekly, the plots (inoculated and uninoculated areas) were examined for symptoms of blossom blight. As the blight was not detected, the inoculation step was repeated on Aug 19 and 29. Another week of observation passed with still no signs of the disease. The inoculation step was therefore repeated on Aug 2 and 21 and Sept 9. Few if any symptoms of blossom blight were observed. The coriander crop did develop minor amounts of aster yellows and a fungal disease which was restricted to the lower, senescent leaves.

Conclusion - natural infection supplemented by inoculation with *Aureobasidium* spores failed to trigger development of blossom blight in the 2002 coriander crop. This may reflect:

- a) problems with the inoculum such as loss of viability or damage incurred in the spray process. However, the spores germinated normally under laboratory conditions and similar methods of spray application had been used in previous trials,
- b) field conditions may not have been suited to development of the disease. This seems unlikely as the crop was managed in a manner known to be conducive to development of disease (ie; irrigated production in a sheltered area. The fact that the trial was inoculated on 6 different occasions over the course of over a month should have increased the odds of experiencing suitable conditions for disease establishment.
- c) *Aureobasidium* may not be the causal organism of classical blossom blight in coriander. This possibility will need to be examined in future controlled environment trials.

The coriander crop was harvested at full maturity. The trash was lightly incorporated back into the plot to serve as inoculum for next years trials.

Dill

As the putative causal organisms for blossom blight of dill (*Fusarium culmorum* and *F. sporotrichioides*) are ubiquitous in soils and as contaminants on the seed coat it was felt that there was no need to inoculate the 2002 dill crop. The crop was managed to produce a lush, disease prone canopy. This objective was met, with the canopy exceeding 2 m in height. However, at no time was there any indication of disease in the crop beyond a limited incidence of aster yellows. The 2002 dill crop was harvested at maturity and the crop residues were spread over the plot to serve as inoculum source for the 2003 crop.

Conclusion - the causal organisms for blossom blight of dill do not appear sufficiently common or

widespread to represent a dependable inoculum source. The 2003 crop should be inoculated at flowering to insure more predictable infestation.

The dill seed crop was harvest at full maturity in early October. The majority of the crop residues were baled and removed as they would have impeded cropping the next year. Enough residues were left to represent a source of inoculum for any disease present in the previous crop.

Enhancing Seed Performance of Spice Crops

Seed of Umbelliferous plants like caraway, cumin, carrot, and dill have immature embryos which must go through a maturation stage before the seed can sprout. This maturation stage begins once the seed is adequately hydrated and proceeds at a rate highly dependent on prevailing temperatures. Low soil temperatures and inadequate soil moisture interfere with this maturation stage, resulting in poor or slow emergence. Slow and incomplete emergence leaves these crops open to weed competition. Seed priming involves taking seed through the initial hydration and enzyme activation steps under controlled conditions in the laboratory. Seeds are typically immersed in aerated water or water plus specific salts. The duration of the priming step must be regulated so that the imbibition and enzyme activation steps are completed but the seed must not begin to sprout. The primed seed is then dried back down enough to allow it to flow through the seeding equipment. Primed seed germinates more quickly and produces a better stand than standard seed, particularly when small seeded crops with immature embryos are seeded into sub-optimal conditions. Priming is commonly employed to enhance establishment of amenity grass or recalcitrant species such as ginseng. The addition of KNO_3 and salicylic acid to the priming solution enhances the efficacy of this process in some species. The mechanism underlying this response is largely unknown.

The objective of this trial was to determine if priming could be used to enhance the seed performance of several spice crops. The initial trials were conducted on petri dishes, but in a subsequent trial the performance of the primed seed was evaluated under field conditions.

Tests were conducted on dill, caraway, carrot and cumin seed. The cumin seed was old and of low vigor, while the seed of the other crops was fresh and high quality.

Petri Dish trial

Seed of each crop was treated to one of four treatments: 1) no priming, 2) primed in distilled water, 3) primed in distilled water with 100 mg/L acetylsalicylic acid added (Rajasekaran et al 2002) or 4) primed in distilled water with 0.01 M KNO_3 added (Maynard and Hochmuth 1995). The seed was primed in aerated solutions for 24 h, then dried on the bench top for 24 h before being plated out. Twenty-five seeds of a given treatment were placed in petri dish containing two sheets of moistened filter paper. Half of the dishes were incubated in the dark at 10C while the other half were incubated at 23C. Germination was observed daily. The seeds were considered as having germinated once the radical reached 1 mm in length.

Field trial

The field trial was conducted at the Dept of Plant Sciences Horticulture Field Research Station in Saskatoon. This site features a heavy Sutherland series clay soil which is very slow to warm in the spring. The plot area was shallow rotovated just prior to seeding. Early planting is desirable for most spice crops as it maximizes the effective duration of the growing season. However, excessively early planting exposes the crop to sub-optimal soil temperatures and/or frost after emergence. This trial was seeded on June 10, which is about 3 weeks later than normal. The delay was necessary to get the heavy clay field dry enough to properly prepare the seedbed. Soil temperatures in the clay soil at that time would have been comparable to a lighter soil several weeks earlier. A push-type precision seeder was

used to seed replicated (4) 2 m long rows of seed from each priming treatment. The plots were seeded relatively shallow but were lightly irrigated immediately after seedling. Emergence was evaluated daily.

Results

Petri Dish trial

Table 3. Influence of seed priming treatments on speed of emergence and percent germination of several crops in petri dish trials at two temperatures.

	10°C		23°C	
	T-50 (days)	Germination %	T-50 (days)	Germination %
CARAWAY				
Control	6	73	3	60
Primed	6	78	3	80
Primed + ASA	6	73	3	74
Primed + KNO3	6	70	2	64
CARROT				
Control	5	69	1	90
Primed	3	78	1	80
Primed + ASA	4	73	1	80
Primed + KNO3	3	65	1	83
CUMIN				
Control	7	37	7	26
Primed	8	37	5	42
Primed + ASA	7	38	4	43
Primed + KNO3	8	36	5	33
DILL				
Control	8	71	4	72
Primed	7	67	4	67
Primed + ASA	7	61	2	62
Primed + KNO3	7	72	2	80

T-50 = time to 50% of the final emergence %.

Although the crops varied considerably in their vigor and tolerance of sub-optimal germination temperatures, their responses to the priming treatments were quite consistent - none of the priming treatments produced any appreciable improvement in seed performance in terms of either speed of germination (T-50) or the % of the seed that germinated.

Field Trial

The clay soil type present at the test site is slow to warm and is prone to waterlogging and crusting, making it less than ideal for emergence of small seeded crops. Weather conditions following seeding were however, relatively favorable, with no rain and warm temperatures. The dill emerged within 10 days of planting, followed a day later by the carrots, then the caraway and finally the cumin. The stand in the cumin crop was exceptionally poor. In part this reflects the relatively low quality of the seed source (40% germination under ideal conditions), but the final stand of less than 10% reflects additional problems with field establishment. The cumin stand was too poor to determine any effects of the priming treatment. The control treatments produced an 80% stand in the dill crop. All three of the priming treatments resulted in a poorer stand than the control. A similar trend was seen in the carrots, with the priming treatments reducing the final stand to a fraction of that obtained from the non-primed controls. In the caraway plots, the stand obtained by priming with ASA was twice as good as that obtained with the other treatments including the non-primed controls. Priming had no effects on the speed of germination for any of the crops.

Conclusion - the range of priming treatments evaluated in this trial provided little in the way of positive effects on germination or emergence of several spice crops under controlled or field conditions. In many cases, the performance of the seed was sub-optimal, indicating the need for some form of treatment. It is possible that the factors limiting the performance of the seed (ie; low vigor or poor field conditions) were not amenable to correction by priming. Alternatively, other priming treatments could be considered. **Until effective methods of treating seed to enhance its performance are available, growers should stick to tried and prove practice of carefully planting good seed into well prepared warm moist soil.**

Table 4. Influence of seed priming treatments on speed of emergence and stand of several spice crops under field conditions.

	T-50 (days)	% Final Stand
CARAWAY		
Control		30
Primed		20
Primed + ASA		68
Primed + KNO3		26
CARROT		
Control		90
Primed		10
Primed + ASA		12
Primed + KNO3		15
DILL		
Control		80
Primed		43
Primed + ASA		53
Primed + KNO3		44

T-50 = time to 50% of the final emergence %.

Poor conditions in the spring and throughout 2002 had a negative impact on the advanced screening and selection component of this project. Expenditures were consequently well below the scheduled amount. **In March of 2003, we requested and were granted a no-cost extension to cover the breeding and selection component of this project.** Planning for the 2003 trials is underway.

Project Related Extension Activities

- the results of the project were presented to the industry at the Annual Conference of the Saskatchewan Herb and Spice Growers Association in January of 2003.
- a summary of the results will be made available to the industry and SAFRR personnel.

Acknowledgments - the support received from TAD has be acknowledged at all presentations and field tours.